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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/538,306	06/09/2005	Makoto Ueki	Q88465	3461
23373 7590 04/05/2007 SUGHRUE MION, PLLC 2100 PENNSYLVANIA AVENUE, N.W. SUITE 800 WASHINGTON, DC 20037			EXAMINER ARORA, AJAY	
			ART UNIT	PAPER NUMBER
			2811	
SHORTENED STATUTORY PERIOD OF RESPONSE		MAIL DATE	DELIVERY MODE	
3 MONTHS		04/05/2007	PAPER	

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

**Office Action Summary**

Application No.

10/538,306

Applicant(s)

UEKI ET AL.

Examiner

Ajay K. Arora

Art Unit

2811

**– The MAILING DATE of this communication appears on the cover sheet with the correspondence address –**  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 19 January 2007.
- 2a) ☒ This action is FINAL. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 17-19 and 21-25 is/are pending in the application.
- 4a) Of the above claim(s) 7-16 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 17-19 and 21-25 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

## DETAILED ACTION

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 17, 19, 21, 23, 24 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Andricacos (IDS reference EP 0751567 A2), hereinafter Andricacos, in view of Nakasaki (IDS reference JP 2-165632 A), hereinafter Nakasaki.

Regarding claim 17, Andricacos (refer to Figures 3) teaches a copper alloy for wiring (Col. 5, lines 31-36) composed of a polycrystalline copper alloy containing Cu (copper) as a primary element and an additional element (Col. 5, lines 49-54), wherein concentration of the additional element is, at grain boundaries of crystal grains composing the polycrystalline copper alloy and in vicinities of grain boundaries, higher than that of the inside of the crystal grains, a barrier layer (22) is formed to surround the polycrystalline copper alloy, and concentration of the additional element is, at the interface between the polycrystalline copper alloy and the barrier layer and in

Art Unit: 2811

vicinities of said interface, higher than that of the inside of the crystal grains (Col. 6, lines 41-44).

However, Andricacos does not teach that the additional element is at least one of the claimed group. Nakasaki (refer to English abstract) teaches a copper alloy for wiring composed of copper as a primary element, with intermetallic compound of copper deposited in grain boundaries, wherein the additional element is at least Zr (zirconium). It would have been obvious to one of ordinary skills in the art at the time of the invention to modify the copper alloy of Andricacos so that the additional element is at least Zr (Zirconium). The ordinary artisan would have been motivated to modify Andricacos for at least the purpose of suppressing intercrystalline diffusion and reducing wiring resistance (refer to English abstract of Nakasaki, last sentence).

Regarding claim 19, Andricacos (refer to Figures 3) teaches a copper alloy for wiring (Col. 5, lines 31-36) composed of a polycrystalline copper alloy containing Cu (copper) as a primary element and an additional element (Col. 5, lines 49-54), wherein

concentration of the additional element is, at grain boundaries of crystal grains composing the polycrystalline copper alloy and in vicinities of grain boundaries, higher than that of the inside of the crystal grains (Col. 6, lines 41-44), and concentration of the additional element in the crystal grains is 0.1 atomic percent or less (Col. 5, lines 49-53).

Art Unit: 2811

However, Andricacos does not teach that the additional element is at least one of the claimed group. This limitation has already been addressed in view of Nakasaki for claim 17 above.

Regarding claim 21, Andricacos teaches that at the crystal grain boundaries and/or in the vicinities of grain boundaries, intermetallic compounds of Cu and at least one element are formed. However, Andricacos does not disclose that the said one element is one of the elements as claimed. This limitation is also addressed by Nakasaki (refer to the rejection of claim 17 above).

Regarding claim 23, Andricacos (refer to Figure 3) teaches a semiconductor device comprising a substrate (substrate of 26) on which a semiconductor element is formed, and a metal wiring (labelled Cu Alloy) composed of the copper alloy for wiring as set forth in any one of claims 17, 18, 19, 21 or 22.

Regarding claim 24, Andricacos teaches the copper alloy for wiring in any one of claims 18, 19, 21 or 22, wherein

concentration of the additional element at the grain boundaries and in the vicinities of grain boundaries is at least 120% of the additional element concentration at the inside of the crystal grains (Col. 3, lines 44-51), and further teaches that the concentration of the additional element at the grain boundaries and in the vicinities of grain boundaries may approach saturation (Col. 6, lines 41-44). Therefore, Andricacos

Art Unit: 2811

teaches the copper alloy for wiring wherein concentration of the additional element at the grain boundaries and in the vicinities of grain boundaries is on the order of 2 to 1000 times the additional element concentration at the inside of the crystal grains.

Regarding claim 25, Andricacos teaches the copper alloy for wiring wherein

concentration of the additional element at the grain boundaries and in the vicinities of grain boundaries is at least 120% of the additional element concentration at the inside of the crystal grains (Col. 3, lines 44-51), and further teaches that the concentration of the additional element at the grain boundaries and in the vicinities of grain boundaries may approach saturation (Col. 6, lines 41-44). Therefore, Andricacos teaches the copper alloy for wiring wherein concentration of the additional element at the grain boundaries and in the vicinities of grain boundaries is on the order of 10 to 100 times the additional element concentration at the inside of the crystal grains.

Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Andricacos in view of Lee (US 5,552,341), hereinafter Lee.

Regarding claim 18, Andricacos (refer to Figures 3) teaches a copper alloy for wiring (Col. 5, lines 31-36) composed of a polycrystalline copper alloy containing Cu (copper) as a primary element and an additional element (Col. 5, lines 49-54), wherein the additional element is at least Sn (Col. 5, lines 31-36), and

Art Unit: 2811

concentration of the additional element is, at grain boundaries of crystal grains composing the polycrystalline copper alloy and in vicinities of grain boundaries, higher than that of the inside of the crystal grains (Col. 6, lines 41-44).

However, Andricacos does not disclose that "the oxide of the additional element are formed at said grain boundaries and/or in vicinities of said grain boundaries". Lee (US 5,552,341) discloses alloy compositions for wiring, teaching that it is desirable to form an oxide on the surface of the diffusion barrier layer and in the grain boundary thereof (Col. 5, lines 66-67). It would have been obvious to one of ordinary skills in the art at the time of the invention to modify the device of Andricacos so that the oxide of the additional element are formed at said grain boundaries and/or in vicinities of said grain boundaries. The ordinary artisan would have been motivated to modify Andricacos for at least the purpose of improving effectiveness of the diffusion barrier (see Lee, Col. 6, lines 1-2).

Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Andricacos in view of Nakasaki, and further in view of Lee.

Regarding claim 22, Andricacos as modified by Nakasaki teaches substantially the copper alloy for wiring but does not teach that at the crystal grain boundaries and/or in the vicinities of grain boundaries, "oxides of at least one element selected from a group consisting of Ti, Zr, Hf, Cr, Co, Al, Ni, Mg, and Ag" are formed". Lee (US 5,552,341) discloses alloy compositions for wiring, teaching that it is desirable to form an oxide on

Art Unit: 2811

the surface of the diffusion barrier layer and in the grain boundary thereof (Col. 5, lines 66-67). It would have been obvious to one of ordinary skills in the art at the time of the invention to modify the device of Andricacos so that the oxide of the additional element are formed at said grain boundaries and/or in vicinities of said grain boundaries. The ordinary artisan would have been motivated to modify Lin for at least the purpose of improving effectiveness of the diffusion barrier (see Lee, Col. 6, lines 1-2).

### ***Response to Arguments***

Applicant's arguments filed 01/17/2007 have been fully considered.

Applicant's argument on page 10 regarding the term "and/or" is noted. The argument is persuasive and the rejection of claims 21 and 22 under second paragraph of 35 U.S.C. 112, is withdrawn.

On page 12, applicant argues that Andricacos' disclosure a concentration of "at least 120%" does not anticipate the range required by claims 24 or 25. This argument is not persuasive. Andricacos' disclosure states "at least 120%" but does not provide an upper limit. Therefore, it encompasses all values above 120%. In practice, one of ordinary skill in the art would know that there is a practical saturation limit for the processes available today. Absent the disclosure of any new processes by the applicant that can enable attainment of new saturation levels not possible by

Art Unit: 2811

Andricacos, the broadest reasonable interpretation of "at least 120%" is that it encompasses all values above 120%.

On page 13, applicant argues that "there is no reference to copper or copper alloys being suitable for use in the disclosure of Lee". This argument is not persuasive.

Referring to (Col. 5, lines 66-67), Lee's teaching that "It is desirable to form an oxide on the surface of the diffusion barrier layer and in the grain boundary thereof, in order to improve the characteristics of the diffusion barrier layer in the contact hole" is a generic teaching and not specific to aluminum alloys. That is why Lee qualifies the above statement (see Col. 6, lines 2-7) by presenting issues that he considers may potentially arise specifically with Al alloys.

On page 14, applicant's argument about claim 21 are moot in view of the new ground(s) of rejection of claim 21 necessitated by applicant's amendment.

### ***Conclusion***

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

Art Unit: 2811

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ajay K. Arora whose telephone number is (571) 272-8347. The examiner can normally be reached on Mon through Fri, 8am to 4:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Richard Elms can be reached on (571) 272-1869. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Art Unit: 2811

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

  
Sara Crane  
Primary Examiner